X-ray Diffraction Microscopy Across the Spectrum: Soft (1~2.6 keV) and Hard X-rays for Materials Science and Biology

Changyong Song[1], Damien Rammuno-Johnson[1] , Huaidong Jiang[1], Adrian P. Mancuso[1], Yoshinori Nishino[2], Yukio Takahashi[2], Yoshiki Kohumura[2], Tetsuya Ishikawa[2], David Patterson[3], Martin D. de Jonge[3], Christoph Rau[3], Ian McNulty[3], Chien-Chun Chen[4], Ting-Kuo Lee[4], and Jianwei Miao[1]

[1]Department of Physics and Astronomy, UCLA, Los Angeles, CA 90095, USA.
[2]SPring-8/RIKEN, 1-1-1, Kouto, Mikazuki, Sayo-gun, Hyogo 679-5198, Japan.
[3]Advanced Photon Source, Argonne National Laboratory, Argonne, IL 60439, USA.
[4]Institute of Physics, Academia Sinica, Taipei, Taiwan.

The X-ray diffraction microscope is a versatile probe to characterize nano-scale materials and biological specimens. With significant effort over the last several years it has now reached a point that this novel imaging technique can be applied to address certain scientific questions. Our recent progress includes the exact oversampling of diffraction patterns for improved phase retrieval [1] and the implementation of a guided hybrid-input-output algorithm (GHIO) for consistent image reconstruction. By using equally sloped tomography, we carried out a quantitative 3D imaging of a heat-treated GaN particle with each voxel corresponding to 17x17x17 nm^3. We observed the platelet structure of GaN and the formation of small islands on the surface of the platelets, and successfully captured the internal GaN-Ga_2O_3 core shell structure in three dimensions [2]. Furthermore, we have developed a labeling technique to tag specific target proteins in yeasts and chromosomes using quantum dots. These developments allowed us to tackle various intriguing scientific problems in nano-structured materials, bio-minerals and single biological cells at an appropriate length scale.

This work was supported by the U.S. Department of Energy, Office of Basic Energy Sciences (DE-FG02-06ER46276) and the U.S. National Science Foundation, Division of Materials Research (DMR-0520894). Use of the RIKEN beamline, BL29XUL at SPring-8 was supported by RIKEN. Use of APS was supported by the U.S.DOE under the contract No. W-31-109-ENG-38.

[1] C. Song, D. Ramunno-Johnson, Y. Nishino, Y. Kohmura, T. Ishikawa, C.-C. Chen, T.-K. Lee, and J. Miao, “Phase retrieval from exactly oversampled diffraction intensity through deconvolution”, *Phys. Rev. B*, 75 12102 (2007).

[2] J. Miao, C.-C. Chen, C. Song, Y. Nishino, Y. Kohmura, T. Ishikawa, D. Ramunno-Johnson, T.-K. Lee and S. H. Risbud, “Three-DimensionalGaN-Ga2O3 Core Shell Structure Revealed by X-Ray Diffraction Microscopy”, *Phys. Rev. Lett*.97 215503 (2006).